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HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION

1924

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Issued July, 1925

WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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HONOLULU, HAWAII

Under the supervision of the
U. S. DEPARTMENT OF AGRICULTURE

Washington, D. C. July, 1925

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1924

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SUMMARY OF INVESTIGATIONS

By J. M. Westgate, *Director*

The station continued during the year its policy of promoting diversified agriculture with a view to making the islands economically independent. Studies were made of the various problems arising in connection with the development of minor crops, and much time was devoted to production, transportation, and marketing investigations preparatory to meeting the demand for information which must result from the awakening of an interested public to the commercial possibilities of these crops. It is the aim of the station to place the minor crops on a profitable basis so that they may supplement economically the sugarcane and pineapple crops, the two leading products of the islands.

The need for diversification in all lines of work is intensified by reason of changes in economic conditions and is plainly discernible in the inclinations of the rising generation, many of whom are not content to remain on the sugar and pineapple plantations as were their forefathers. The development of new agricultural industries would open a wide field of specialized employment for the numerous nationalities and racial mixtures making their home in Hawaii and would tend to offset the troubles usually resulting from unsettled labor conditions.

The establishment of a new steamship service between Honolulu and the Pacific coast has aroused interest in the development of new agricultural enterprises of the islands furnishing products to be shipped to the markets of the mainland. This has thrown a new and interesting light on the problem of island production for commercial purposes, and should serve as a stimulus in the upbuilding of the lesser agricultural industries of the islands.

The meeting of the Pan-Pacific Conservation Congress, to be held under the auspices of the Pan-Pacific Union in Honolulu from July 29 to August 14, 1924, emphasizes the fact that the world in general is beginning to realize the need of adequately conserving its food production resources. Delegates from various parts of the world, including officials of the U. S. Department of Agriculture, will discuss subjects which have engaged the earnest attention of the station since its inception.

Owing to a renewed interest in horticulture throughout the Territory and to an ever-increasing demand for fruit for local consumption as well as for shipping to foreign markets, the horticultural division was more heavily burdened with requests for information and assistance than at any time within recent years. Cultural practices were developed in connection with the growing of certain fruit crops which are commercially important or give promise of becoming so; and efforts were made to improve plants by seed selection and to propagate by asexual methods. In this connection, seeds were collected to produce rootstocks for use in budding and grafting experiments. Approximately 40,000 plants and packages of seed of improved varieties were distributed to local cooperators and private growers promising to give the plantings proper care, and to interested growers in other parts of the world. New species and varieties of fruits and nuts were brought in from foreign places for test to determine their adaptability to local conditions. The furnishing of suitable instructions for economic plant culture is serving to encourage the habit of growing food crops by people who formerly were inexperienced and not interested in the matter.

Agronomic work was centered largely on diversified food crops for man, and on forage crops for dairy cattle, root crops for pigs and other livestock, and green manuring crops for use in the maintenance of soil fertility. Many of the crops were tried for the first time. Special attention was given to sweet-potato breeding and to the development of new and improved varieties of peanuts and pigeon peas. The work of the year was considerably hampered by two heavy rains which washed the experimental fields to such an extent as to necessitate some replanting. The agronomist gave afternoon and evening talks and demonstrations on popular agricultural subjects to members of the boys' and girls' clubs, and published occasionally timely articles in a paper issued by the University of Hawaii. He also assisted poultry producers in problems connected with the industry.

Work in the chemical division was directed toward the development of the technical phases of the diversified agricultural industries, and included within its scope the production and study of edible canna for starch-manufacturing purposes, the determination of fertilizer and soil requirements for the most profitable production of bananas, and special investigations with the pineapple crop, which is rapidly increasing in importance throughout the islands. Much assistance was rendered the manufacturers of jelly and other fruit products. The making of commercial products from tropical fruits is regarded as an industry of considerable moment, owing to the fact that quarantine regulations prohibit the exportation in the fresh state of any fruits except bananas and pineapples.

The extension agent for the island of Hawaii assisted farmers and homesteaders in obtaining improved varieties of seed, and gave advice concerning improved methods of tillage and harvesting and the application of fertilizers to the various soils of the island. He was also instrumental in helping growers market their products, and devoted considerable of his time to school children, members of the boys' and girls' clubs, and the Boy Scouts in an effort to cultivate in them a liking for work of an agricultural nature. Demonstration meetings were held for this purpose and short talks given. During the year covered by the report, the agent traveled over 11,000 miles, extending the results of the work of the central station and discussing farm problems with homesteaders, farmers, and ranchers. Fully 60 per cent of his time was spent in the field, making personal visits, attending club meetings, and promoting club interests.

The boys' and girls' club work, conducted under the direction of a club leader, continues to be a very popular feature of extension. A total of 582 children were enrolled in this work, including sewing, corn culture, canning, home management, rabbit, pig, and poultry raising, and gardening. In connection with the work of these clubs there has been developed what is known as a "vacation garden club," which numbers among its members children who are not actively employed elsewhere during the summer. A large tract of land on the Territorial fair grounds has been made available for the club members, and plans are under way for a demonstration of their work at the Territorial Agricultural Fair, which is to be held October 20–25.

At the Tantalus substation, Oahu, trials were again made of such crops as are not adapted to growth at the central station. This substation is about 1,000 feet higher than the central station and offers conditions differing from those at the lower elevation. The plantings were largely of a horticultural nature, owing to the intensive terracing which is required on the steep slopes.

At the Haleakala substation, Maui, numerous varieties of diversified crops were produced under the immediate direction of the agronomist of the central station. Experimental plantings of many others also were made in small plats or in single rows for trial on a larger scale later.

The central station, working in cooperation with the Parker ranch, has had general oversight of a 10-acre tract on which are growing over 100 different varieties of forage crops, especially grasses, for experimental purposes. The work is financed by the Parker ranch. The extension agent assisted in planning the arrangement and kind of plantings and in obtaining the planting material. The more promising of these varieties will be distributed to interested homesteaders on the island of Hawaii.

During the year the following publications were issued by the station: Bulletin 49, The Acid Lime Fruit in Hawaii, and Bulletin 50, The Sweet Potato in Hawaii. The following were submitted for printing during the year: Annual Reports for 1922 and 1923; Bulletin 51, The Guatemalan Avocado in Hawaii; Bulletin 52, Manganese

Chlorosis of Pineapples: Its Cause and Control; Bulletin 53, The Hawaiian Tree Fern as a Commercial Source of Starch; and Bulletin 54, Edible Canna in Hawaii.

REPORT OF THE HORTICULTURAL DIVISION

By W. T. Pope, *Horticulturist*

BANANAS

Interest in banana culture considerably increased during the year, owing to a growing demand for Hawaiian varieties in mainland markets. Improved freight service is transporting practically all the choice sorts to the mainland, and local consumption is greater than ever before. These demands are reasonably stable because the banana is well known as a fruit of high food value. It gives quick returns and can be grown on thousands of acres which are not adapted to the growing of other commercial crops.

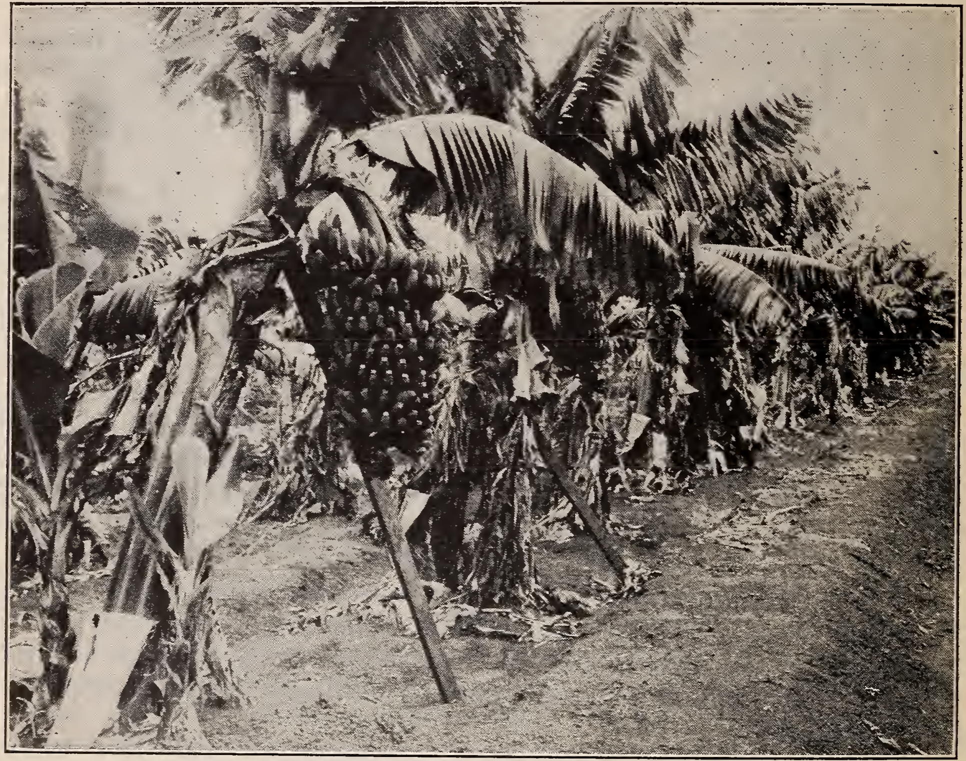

Fig. 1.—Chinese or dwarf banana, *Musa cavendishii,* Mokuleia, Oahu

In a recent survey, made to determine the cultural possibilities of the banana, the best varieties for culture, and the like, it was found that five locally grown varieties—the Chinese or dwarf (fig. 1), Bluefields, Maiamaoli, Brazilian, and Red Spanish—can be produced on a very much larger scale commercially than is now the case. All the planting material required for the development of these varieties can be obtained within the Territory, thus precluding the introduction of plant diseases and insect enemies. In Hawaii bananas are free from insect pests and from diseases, except the freckle disease.

Twenty-eight varieties are being grown at the station for determination of their commercial possibilities. The varieties growing at the Tantalus substation were seriously retarded by the drought of 1923. Since that time, however, maturity has been reached by some of the varieties of which the station had no pomological descriptions.

AVOCADOS

Investigations are being continued with different varieties of avocados fruiting at certain seasons in the hope of extending the fruiting period throughout the year. Interesting data regarding fruit production are being collected on a number of the many varieties under observation. Some of the Guatemalan varieties matured their first crops at different seasons depending upon the elevation at which they were growing. Nimlioh, for example, fruited in the fall at an elevation of 100 feet, while trees 1,000 feet higher matured about five months later. The Macdonald fruited in December at an elevation of 60 feet in Honolulu and five months later at an elevation of 1,350 feet on the island of Hawaii.

In connection with propagation work, the greatest success has been had in developing trees through forced and vigorous growth of both seedling stocks and scions. Given proper attention, selected seedlings planted in July should be large enough to bud in 40 to 60 days and as budded trees may be grown to sufficient size to permit of transplanting to the orchard the following spring.

Several 1-acre experiments were started during the year and a number of budded trees of selected varieties were distributed to interested growers. Bud wood from the orchard was furnished to nurserymen and others requesting it. New avocados, variety hybrids of various kinds, such as crosses between the West Indian and Guatemalan types, came into bearing during the year. Some of these give promise of becoming valuable additions to the orchard.

Methods of control were successfully worked out for the avocado mealybug (*Pseudococcus nipæ*), the wood-boring beetle (*Xyleborus immaturus*), and green caterpillars of the tortricid moth (*Amorbia emigratella*), which have given avocado growers considerable trouble for some time.

GRAPES

Experimental work with grapes continues to be satisfactory. During the year varieties were introduced from Georgia, Florida, and California, where climatic conditions are somewhat similar to those of Hawaii. It is hoped that the vineyard will furnish propagating wood for use in carrying on experimental cooperative work in other parts of the Territory. The successful adaptation of the Isabella variety to Hawaii indicates that other introduced varieties will do well here. The small Isabella-grape vineyard has been developed mainly to learn the effect of pruning on yield and to serve as foundation stock for budding work. (Fig. 2.)

Probably the only serious obstacle to grape growing in Hawaii is the Japanese beetle (*Adoretus tenuimaculatus*), which feeds on the foliage in some localities and shows a preference for certain varieties.

CITRUS FRUITS

The drought of July, August, and September considerably affected the orchard of miscellaneous citrus varieties; and, in addition to delaying the work of replacing with budded stock some 20 trees which died in former years, prevented planting of the orchard cover crop of cowpeas until very late winter. Several attempts were made to plant, but the light rains failed to cause a satisfactory germination. In March the orchard was pruned, cultivated, and fertilized with barnyard manure. This orchard is of particular value as a source of bud wood for many kinds of citrus. Work is under way for the production of budded stock for use in several additional cooperative experiments with Hawaiian budded oranges.

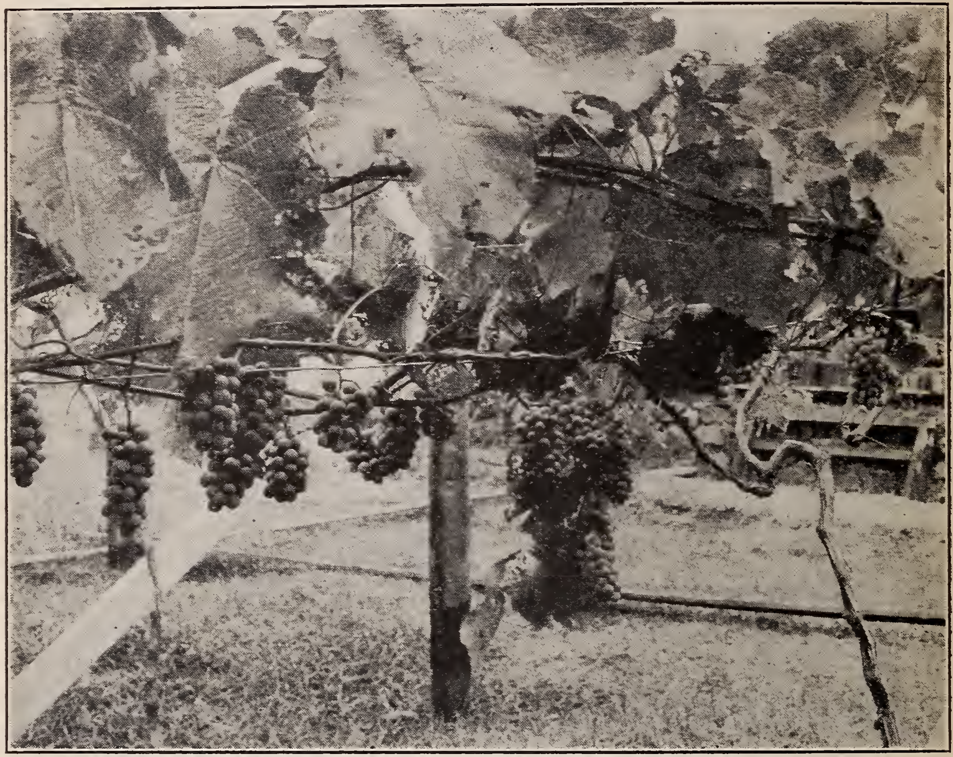

FIG. 2.—Isabella grapes, vine 3 years old

Inspection of cooperative experimental work, which is being conducted on two 1-acre plats in the Kona district of Hawaii, showed that satisfactory progress is being made. Many requests were received during the year from farmers and others for budded Hawaiian orange trees. So far as it is known, there is no citrus nurseryman in the Territory.

PAPAYAS

The demand for papayas is steadily increasing, the station distributing over 10,000 plants from seed during the year. Investigations, undertaken to establish varieties having well-fixed characters, are showing interesting developments. (Fig. 3.) Of the number of different kinds or types which were collected from all over the world for trial, many show a decided tendency to produce fruit of inferior quality at certain seasons. In some instances the fruit undergoes decided changes in size, shape, and quality through cross-pollination. This makes it practically impossible to maintain standard characteristics in the fruit, even when asexual propagation is used, because the groves can not be sufficiently isolated to prevent cross-pollination from nearby inferior trees.

Observations on the papaya at altitudes approximating 1,000 feet indicate that the tree is not adapted to such high elevations, probably because of the cooler temperature and increased rainfall. The fruit produced at such elevations is usually insipid and poorly formed. Even at lower elevations it is often inferior during the cooler months, more especially during continued wet weather, when pollination is seriously affected. The fruit has been observed to set in part without pollination, but in such cases it is seedless and has thin, poorly flavored flesh. Good papayas are produced where pollen is abundant, the fruit then having numerous seeds and thick flesh, which is pleasantly flavored.

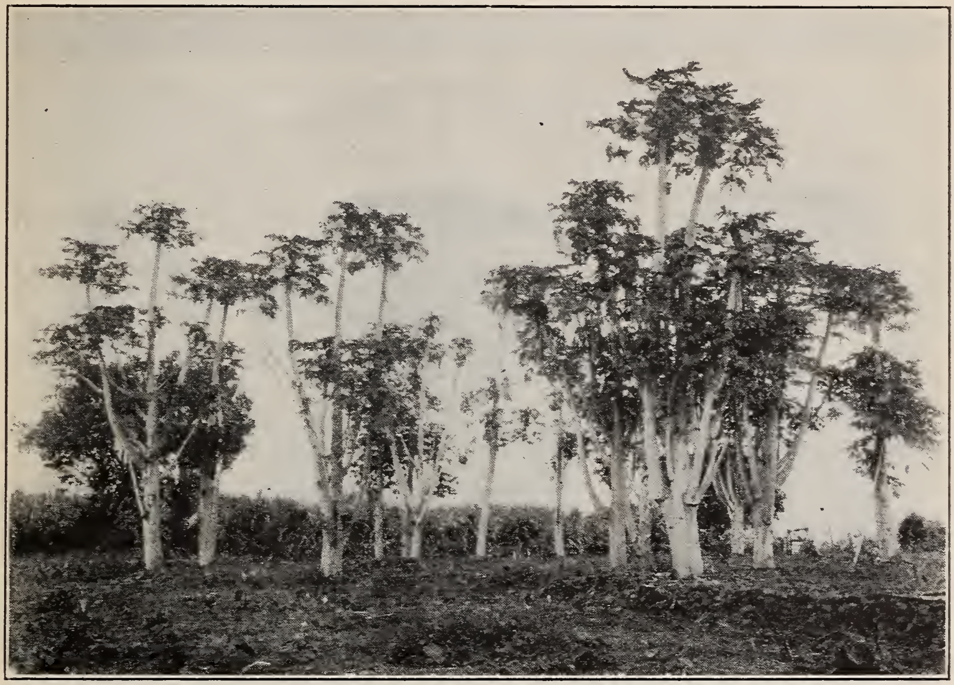

FIG. 3.—Part of a 20-year-old papaya grove, Kona, Hawaii

Cutting and grafting propagation methods have been satisfactorily worked out by the station.

MANGOES

The year was very satisfactory for mango varieties, most of which fruited abundantly. The dry season was harmful only in that it favored the development of insect pests. The orchard was kept thoroughly tilled, except during a part of the winter, when it was planted with a cover crop of cowpeas. The trees were pruned in the fall and occasionally sprayed with Bordeaux mixture for the control of the mango blight (*Glœosporium mangiferœ*), which was rather severe during the previous winter and spring. The variety Victoria produced large crops and fruited somewhat ahead of the regular mango season, maturing the main crop during March, April, and May. This variety shows a tendency to fruit to some extent at other times also. The new variety hybrid (Station Accession No. 3715) (fig. 4), which is the result of a cross between the Cowasjee-Patel and Pirie, came into bearing during the year, producing fruits of good size, quality, and flavor. It was not attacked by the Mediterranean fruit fly.

A new mango orchard was started at the station for the purpose of establishing new and improved varieties and producing a windbreak for the citrus orchard. Sixteen varieties, the greater number of which are grafted trees, were set alternately in rows 30 feet apart. All are doing well. The varieties were selected for the production of fruit which is thought to be immune to attacks of the Mediterranean fruit fly, and for the grouping of trees fruiting at different periods so that the fruit may be in season throughout the year.

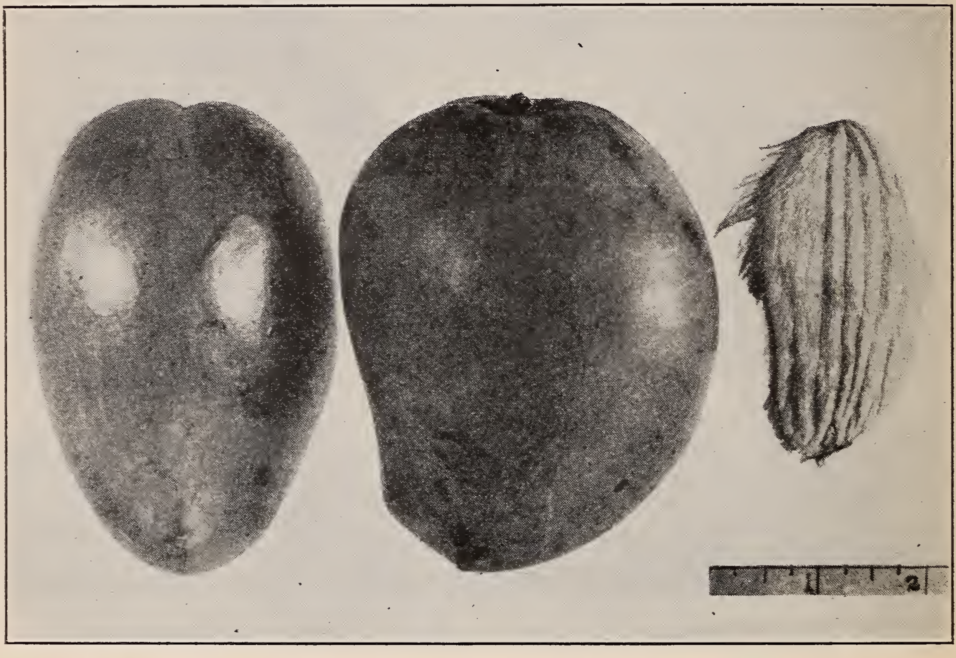

FIG. 4.—Mango, station hybrid (Accession No. 3715). Result of crossing Cowasjee-Patel × Pirie

Improved methods of grafting nursery stock with scions of desirable varieties, as worked out at the close of last year, are being continued. These methods are very successful, occasionally proving 100 per cent satisfactory, when applied to propagating material of a definite kind of growth.

The mango weevil (*Cryptorhynchus mangiferœ*), which enters the husk of the seed in its early stage of growth and causes the fruit to fall before ripening, has been troublesome in some localities. The pest is very difficult to control.

FIGS

The production in various localities of fine crops of figs for use as fresh fruit would seem to indicate that fig culture might be greatly increased in the Territory. With the advent of the Mediterranean fruit fly, fig culture received a setback from which it has had difficulty in recovering. As the ravages of the fly diminish, probably by the introduction of its natural enemies, the fig as a fresh fruit is likely to come into its own again. Infested fruit is only occasionally found, and the attacks of the fly rarely last through the whole fruiting season of a full-bearing tree. The early figs are generally attacked, whereas in the case of oranges the infestations appear near the end of the season.

The station has a few fig trees which have been used as a source of propagating wood. The cuttings are placed in benches of washed coral sand, and within a few weeks root sufficiently to permit of their distribution to any part of the Territory.

Because of its early bearing habit, the fig tree is of especial interest to amateur growers, many of whom acquire a liking for plant culture after experimenting with the fig. Cuttings of the Black Mission fig of California were introduced into Hawaii during the year. This variety will be tried in some of the drier localities. Trees of the Kadota variety, which was recently introduced, are now large enough to fruit and to furnish propagating material.

NUTS

Investigations were continued with the Macadamia or Queensland nut (*Macadamia ternifolia*), the pistachio nut (*Pistacia vera*), and the coconut (*Cocos nucifera*). Of all the varieties under trial at the station, probably the Macadamia attracts the most attention. It is being planted on large areas in several localities and is becoming well known throughout the Territory. Many of the trees have come into bearing, and a survey of climatic and soil conditions indicates that the nut can be grown from sea level to an elevation of 2,100 feet. It makes its best growth, however, between 1,000 and 2,000 feet above sea level.

Other species receiving attention at the station include black and Persian (*English*) walnuts, the almond, and the pili nut (*Canarium ovatum*), a few trees of each of which have been distributed to cooperative growers.

TOMATOES

The production of tomatoes on a successful scale has been a difficult problem since the accidental introduction of the melon fly some 15 years ago. The California varieties fruited in many places, but only in rare instances without being damaged by the fly. The station hybrid, the result of a cross between the well-known Earliana and a wild tomato, is being generally grown because of its ability to resist the attacks of the fly. During the year the station distributed about 7,000 plants of this hybrid. A large number of crosses were recently made in the hope of developing a strong treelike plant producing abundant medium-sized fruit which will be resistant to the ravages of the melon fly. Seedlings of selected crosses are now being grown to ascertain whether they retain the desirable characters of their parents.

MISCELLANEOUS FRUITS

Minor fruits receiving attention at the station include the breadfruit, litchi, strawberry, mulberry, loquat, roselle, pomegranate, annonas, and *Eugenia* spp.

During the year eight new varieties of breadfruit were obtained from Samoa through G. P. Wilder. The cuttings have rooted and grown to sufficient size to indicate the adaptability of the varieties to Hawaiian conditions. A large number of trees have been propagated from the litchi specimens which were early introduced at the station. Strawberry plants growing at elevations above 1,000 feet bear crops during a large part of the year, and the native mountain apple (*Eugenia malaccensis*) is an excellent fruit, which is found growing in both the wild and cultivated state. Many improved plants of the wild type have been distributed by the station. Mulberries produce abundantly at an early age in Hawaii. Annonas do not seem well adapted to local conditions.

Among the fruit plants introduced from many parts of the world may be included the Pejubaye palm (*Guilielma utilis*) and the mangosteen (*Garcinia mangostana*).

REPORT OF THE AGRONOMY DIVISION

By H. L. Chung, *Agronomist*

TRIP TO THE ORIENT

During the early part of 1923 the agronomist visited the Orient, including Japan and China, for the purpose of getting information relative to agricultural and general farming methods applicable to Hawaiian conditions.

It was observed in connection with animal industry that Chinese ranchers are bringing about an improvement in their native herds by the introduction of purebred animals, beef cattle being imported from England and poultry from New York. Owing to its nearness to the Orient, compared with Europe and America, Hawaii doubtless could be made the clearing house for the disposal of improved strains of stock to the Orient, with the distinct advantage to the purchaser of a shorter ocean trip for his animals and a consequent saving in transportation charges.

Seeds were secured in Peking, Shanghai, and Canton and forwarded to the Bureau of Plant Industry, U. S. Department of Agriculture, for test. Since then a large collection of plants has been received, including winter and bitter melons, green turnips, amaranthus, rape, and peanuts. A large supply of locally grown seeds of these plants is now available for distribution.

GRASSES

Thirty-six species of grasses are being grown on the demonstration plats for observation and for distribution as specimens to the several schools conducting a course in nature study. Living specimens of all the grasses were supplied to the University of Hawaii Farm, and a number of the larger sorts were given to a pineapple company for trial on their uplands in Molokai.

Several selections were made from heavy stooling hills of Napier grass with the object of improving its quality and yield. Likewise. seedlings of Merker grass (*Pennisetum merkeri*) were secured.

CANE

Taking advantage of the rare tasseling of the Uba cane in the station agronomy field, the Hawaiian Sugar Planters' Association hybridized the variety with pollen from several standard commercial varieties. It has been difficult to get the Uba cane to flower. Cuttings produced by the association from the hybrid seedlings will be turned over to the station for test and observation.

CORN

Eight new varieties of corn were imported through a New York seed house for test. The first planting, made April 4, was a failure, due apparently to climatic conditions and to heavy infestation by the corn leafhopper (*Peregrinus maidis*). A second trial, started toward the close of the fiscal year, is showing promising signs. The sweet corn which was developed by the station continues to be the best sweet sort so far as growth is concerned. It is somewhat unstable in some of its minor characters, but remains practically a sugar variety and resists attacks of the corn leafhopper to a much greater degree than is true of varieties brought in from the mainland.

SORGHUM

Tests of six varieties of sorghum from Manchuria for soiling crops and for grain production showed that none possess any advantage over varieties formerly grown at the station. An outstanding stool of sorghum was observed which does not resemble those of the other varieties. It has not yet been determined whether it is a mutant or a chance plant.

Some attention was given to the growing of broomcorn, which is thought likely to prove a profitable crop, provided it is grown on a thoroughly well-tilled soil and is given proper care. Broomcorn can be shipped as raw material to the local broom factory or made into finished brooms on the island of Molokai.

EDIBLE CANNA

Both tops and tubers of edible canna, planted under different cultural methods, were harvested during the year. Experiments are under way to determine the correlation of the physical condition of the soil with yield of tubers. The tests are being carried out on adobe land with which black volcanic sand was incorporated to improve its physical condition.

Edible canna tubers which were introduced from the Porto Rico station during the year failed to show any growth after 19 days, although they were apparently sound. Another shipment has been requested for trial.

CASSAVA

Work with cassava has consisted largely in maintaining the varieties now established and in making the plantings serve as a source of cuttings for growers requesting propagating material. A portion of cassava root, unearthed during the plowing of one of the station fields in December, 1923, was found to be in excellent state of preservation, although it had remained underground and detached from any living plant for over three years. Cassava roots, as a general rule, deteriorate rapidly after they are separated from the plant.

SWEET POTATOES

Of the large number of standard varieties which were received from the mainland three years ago, many bloomed profusely for the first time during the year. These were crossed with native varieties, resulting in the production of 175 seedlings. Almost the whole of the first crop of sweet potatoes was ruined by the sweet potato weevil (*Cylas formicarius*); and the second crop, although free from the weevil, was severely attacked by the leaf miner (*Bedellia orchilella*), which defoliated the entire patch. Notwithstanding the destruction of the crop by these pests, the station was able to supply 10,867 cuttings to sweet-potato growers.

SUNN HEMP

A comparative test, undertaken to ascertain the relative efficiency of sunn hemp (*Crotalaria juncea*) and pigeon peas (*Cajanus indicus*) as quick-growing green-manure crops, was completed during the year. The data obtained show that sunn hemp makes the higher yield of vegetable matter of the two crops for a growing period of 60 days. *Crotalaria assamica* bloomed profusely during the latter part of August, but failed to set seed. Close examination of the plants showed that a portion of the floral parts had been destroyed by the larvæ of *Lycœna bœtica* before the anthers had a chance to open.

PIGEON PEAS

Selection work for improvement in foliage and seed of both the Porto Rican and the Indian varieties of pigeon peas were carried on with very gratifying results (fig. 5).

PEANUTS

Through the courtesy of Edward Shim, four varieties of peanuts were received from China for trial at the station. A white-fleshed variety produced a heavy crop of trailing vines, and numerous seed pods which, however, were devoid of kernels.

The peanut supply of the station has been nearly exhausted by the demands made upon it by the school and home gardeners. However, most of the demands have been supplied from seed stocks on hand.

DISTRIBUTION OF SEEDS AND CUTTINGS

Distribution of seeds and cuttings from July 1, 1923, to June 30, 1924, was made in amounts as follows:

Seeds and cuttings distributed during the fiscal year ended June 30, 1924

Crop	Seed	Cuttings	Crop	Seed	Cuttings
	Pounds	*Number*		*Pounds*	*Number*
Alfalfa	15		Sorghums	13	
Beans	188		Sunn hemp	18	
Corn	236		Grasses	11	17,005
Cowpeas	22		Miscellaneous	6	
Sweet potatoes		10,867	Cassava		836
Potatoes	11		Edible canna tubers		280

POULTRY

Owing to the pressure of agronomic work both at the station and on the other islands, the agronomist was able to give only a limited part of his time to poultry. Interest in poultry raising is everywhere increasing, as is apparent in the many requests for information which are daily received from all parts of the Territory. In order to overcome the various difficulties which beset the average poultry raiser and to develop further the poultry industry in Hawaii, the station should have a poultry specialist who could devote his entire time to poultry problems, or at least there should be an assistant to work with the agronomist.

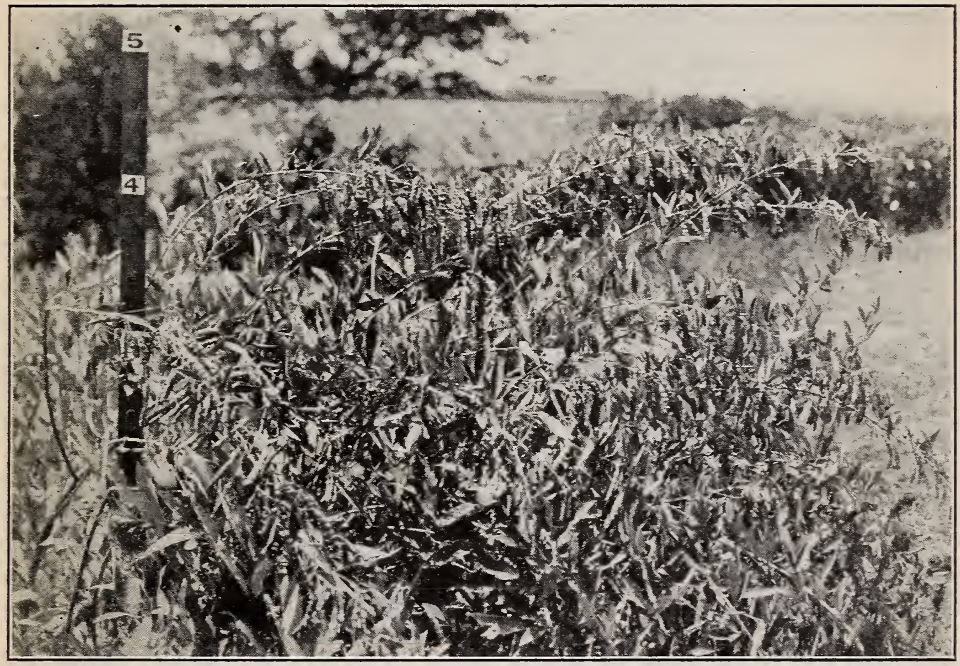

FIG. 5.—Heavily seeded pigeon pea plant, a strain developed by the station

During the year 192 cases of poultry ailments were brought to the attention of the agronomist. Sorehead or chicken pox (epithelioma contagiosum), the most deadly disease of chickens in Hawaii, was conspicuous by its absence until June 10, 1924, when it appeared in flocks throughout Oahu. The agronomist is studying the disease in the hope of finding a preventive and cure. Apoplexy was prevalent in some of the poultry yards of the islands, and during the second egg-laying contest which was conducted by the poultry department of the University of Hawaii many of the contesting hens succumbed to the disease. During the latter part of the year a rancher called the agronomist's attention to his flock of 200 Hawaiian ducks which were dying at the rate of three to five a day from an unknown cause. Apparently normal in the morning, the afflicted birds grew restless toward noon, when they were stricken with paralysis of the legs and wings, followed by death. Examination of living specimens gave negative results, and an inspection of the premises showed that the birds were suffering from heat prostration, there not being sufficient shade for them after they had waded in the warm water pond at noon. The trouble was remedied by making a low arbor of coconut leaves which afforded shade.

Eggs having a high percentage of hatchability were imported from Washington State and successfully incubated. Eggs for hatching purposes should be fresh at the time they are shipped and should be selected from hens which are known to produce fertile eggs. Importations of eggs for hatching should be made from the mainland during January, February, and March.

REPORT OF THE CHEMICAL DIVISION

By J. C. Ripperton, *Chemist*

BANANAS

In experiments which were made to determine the best method of applying fertilizer to bananas, two crops have been harvested and fertilization of the third crop completed. Owing to the very small increases resulting from fertilization of the first two crops, each plat was subdivided at the end of the second crop. One half of each plat was given twice as much fertilizer as had been formerly applied and the remaining half continued to receive the same quantity as formerly.

Studies of the physical properties of the soil as related to banana production were begun, soil samples being selected for analysis from fields of widely differing fertility. The experiment will probably be carried along on a field scale, if results of a positive nature are obtained.

FERTILITY-ROTATION EXPERIMENTS WITH PINEAPPLES, PIGEON PEAS, AND UPLAND SUGARCANE

These experiments undertaken to provide short rotations for pineapple and sugarcane and at the same time to prevent soil depletion by plowing under pigeon peas as a green-manure crop were discontinued. Owing to the remoteness of the experiments, it was found impracticable for the station to keep in sufficiently close touch with them to obtain authentic reports regarding results. Further work with pineapples has already been begun in a more accessible location.

EDIBLE CANNA STARCH

An agricultural industry which appears to be of great potential importance is that of the production of edible canna starch, which has possibilities as a food and for industrial purposes. Results of tests conducted on the mainland indicate that the starch can successfully compete with corn and potato starches on the market. The crop thrives at altitudes which are not suited to sugarcane cultivation and grows in localities that are too wet for pineapple production. It can be grown on extensive areas which are now utilized primarily for grazing and need not therefore compete with the two major crops as regards occupation of the land. The crop can be dug at any stage of maturity and during a labor shortage can be harvested in seasons when the pineapple and sugarcane crops are not mature. Another important advantage of the new industry is that, in case of interruption to shipping, the tubers can be used as an emergency crop, because they have practically the same food value as the potato.

A study of the structure of the plant showed the occurrence of important differences, both as to the character of the starch granules and the physical texture, between the cortex and the fundamental tissues (fig. 6). Investigations were also carried on to learn the extent to which starch is stored in the stalk of plants of different ages and grown under different methods of cultivation, as well as the best method of storing and the feasibility of grinding the tubers and expressing the moisture from the pulp for shipment in the dried state as a means of reducing bulk and transportation charges. Edible canna tubers can not be stored indefinitely in the fresh state because of the rapid darkening of the tissues upon exposure to air. This discoloration is not removed during the process of extraction and lowers the quality of the starch produced. In the method developed by the station for the preparation and shipment of the dried product, darkening of the tissues does not occur, even after the product has been stored for several days. Work on these problems will be continued on a large field scale when time permits.

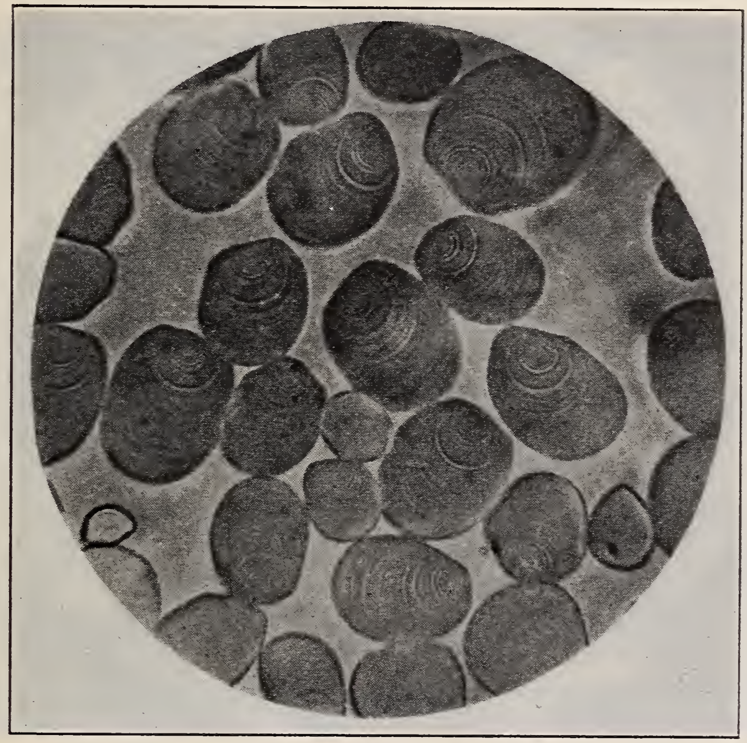

FIG. 6.—Starch granules from fundamental tissues of edible canna. Magnified 220 diameters

The viscosity of the dried products, of the starches made from tubers stored in different ways, and of those prepared from different classes of tubers from various localities and from different parts of the tuber, was determined with the Saybolt standard viscosimeter. This type of viscosimeter is probably not so well adapted for measuring the viscosity of starches as is the torsion instrument. It is generally agreed that starch pastes, as they are prepared for most industrial purposes, are plastic rather than viscous. The experiment will probably be continued with a MacMichael viscosimeter, which is of the torsion type and can be used to determine the plasticity of relatively high concentrations of starch.

Further studies were made of the method of growth of edible canna and of the changes taking place in the plant during various stages of growth. Hills of canna were dug from various fields, and each tuber was classified as to its age and stage of development. A series of tubers of different ages was analyzed, and the analyses were correlated with the age, specific gravity, size, and shape.

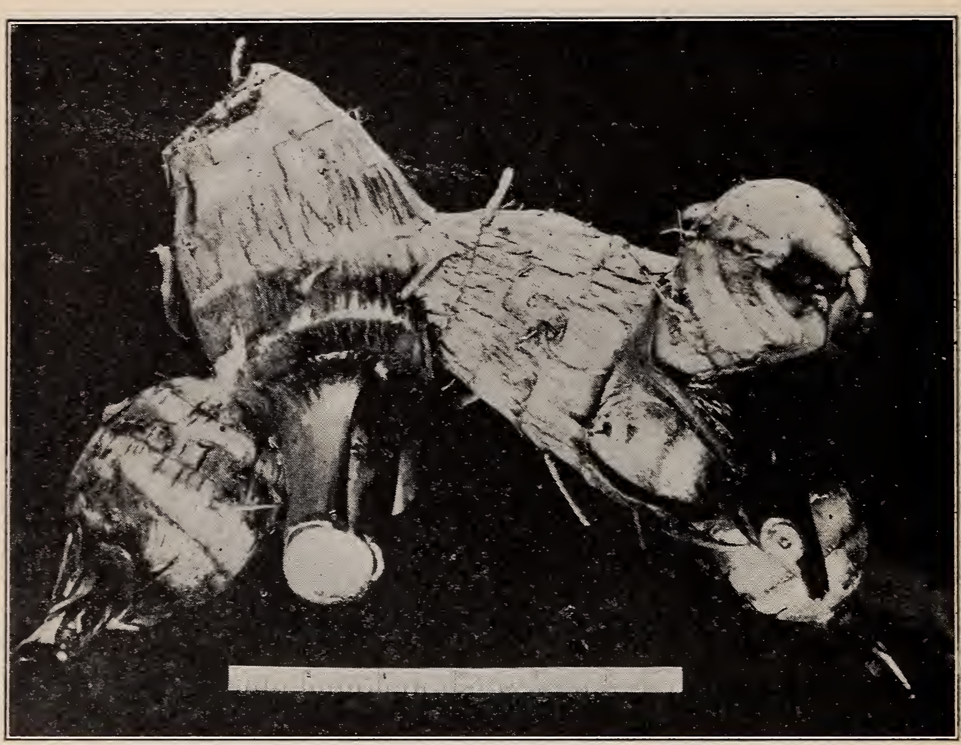

FIG. 7.—Edible canna tubers, or corms, grown at Waimea, Hawaii

At Waimea, Hawaii, a field experiment has been established to ascertain the fertilizers best adapted to canna (fig. 8). In another experiment, planned to learn the best method of applying fertilizer to canna, half the crop was harvested and the other half allowed to remain in the ground, to permit of a study of the changes taking place in the tubers in 12 to 24 months. Other experiments are under way to learn the effect on the nature and yield of tubers of different methods of planting and methods of hilling up the stools, as well as the feasibility of mulching with paper.

JELLY MAKING FROM TROPICAL FRUITS

Since even experienced jelly makers in Hawaii have difficulty in producing a uniform quality of jelly, the station urged upon jelly-making concerns the advisability of testing their fruit juices for jelly-making qualities. The tests were found to be of great importance, especially in connection with the guava, which constitutes the basic material of the fruit-jelly industry of the islands. Juices of uniform quality, with respect to pectin and acid, were produced by adding the determined proportion of water to green guavas, and the resultant jellies of different juices varied widely in color, flavor, texture, and sugar content.

A simplified method of testing the relative acidity of fruit juices was successfully worked out for use in jelly making on a large scale, the necessary apparatus and chemicals being a Mohr pipette, an Erlenmeyer flask, and fifth-normal sodium hydroxide (solution A), and phenolphthalein (solution B) as indicator (fig. 9). The pipette is filled to the mark A with fifth-normal sodium hydroxide, which is then run into the flask and 10 drops of phenolphthalein (solution B) added. The pipette is rinsed with water and filled with the juice to the zero mark. Finally, the juice is titrated with the sodium hydroxide until the color changes. If the color changes with the juice at the E mark, the acidity will be excellent; if at the G mark, good; and if at the F mark, fair. More accurate readings than these can be had by expressing the result as percentage of acid. This, together with the Brix reading of the juice, may be learned by referring to a table giving the proper proportion of sugar that should be added to the juice.

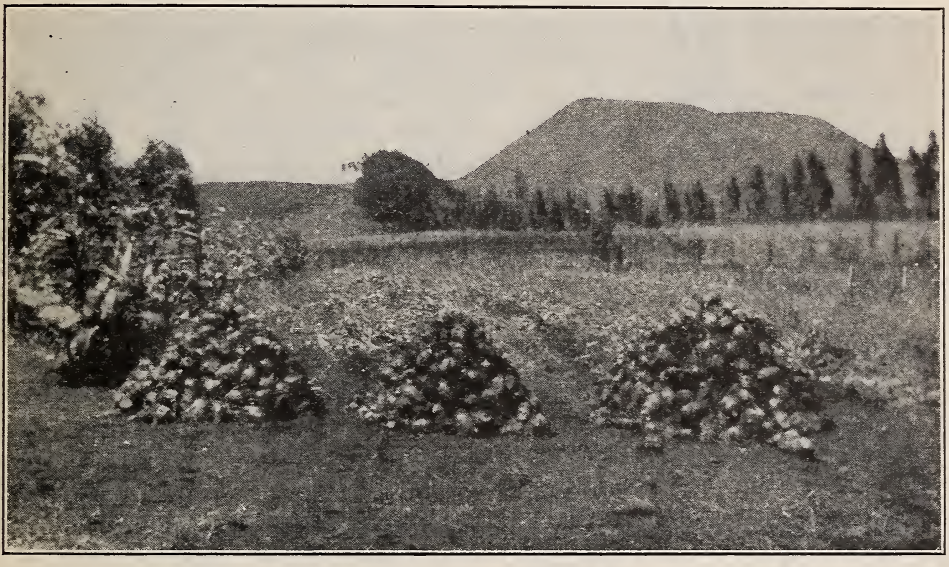

FIG. 8.—Edible canna tubers. Right, 211 pounds from fertilized row, center and left not fertilized, 117 and 121 pounds, respectively

Work is being continued on the development of more convenient methods of determining the pectin content of juices. The Brix hydrometer is a fairly satisfactory means of determining the pectin content of a guava juice, but it is of little value in connection with fruit juices containing a high percentage of sugar, even when a separate table is worked out for each specific juice.

COMPOSITION OF HAWAIIAN-GROWN VEGETABLES

Work with Hawaiian-grown vegetables was continued and analyses of the first crops, grown for experimental purposes on the mainland (Virginia and Washington State) and in Hawaii (Mokuleia and Honolulu, Oahu), were completed. Although variations in the composition of each crop were noted, the results as a whole seem to indicate that locally grown vegetables are fully as high in mineral and nutritive constituents as are the same varieties grown on the mainland. The experiment is being carried through a second crop, the vegetables being grown in the same locations except that one test was shifted from Bellingham, Wash., to Corvallis, Oreg.

Working in cooperation with the agronomist, the chemist is making a study of Orient-grown vegetables to determine their adaptability to Hawaiian conditions and their nutritive and more important mineral constituents.

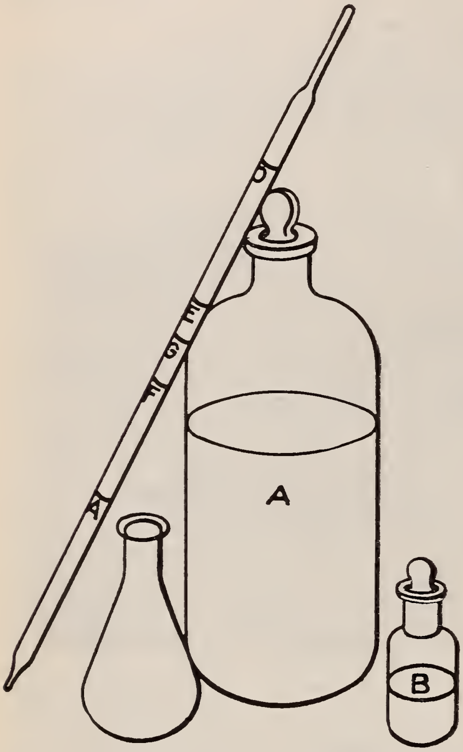

FIG. 9.—Equipment for determining the acidity of a fruit juice

HALEAKALA SUBSTATION AND DEMONSTRATION FARM

By H. F. WILLEY, *Superintendent*[1]

Eucalyptus trees (*Eucalyptus robusta*) are proving especially well adapted as windbreaks to the high altitude of the Haleakala substation, recently redetermined to be 2,100 feet. Smooth Cayenne pineapple plants are making thrifty growth at this elevation, which, so far as it can be learned, is the record height for pineapple growing in the Hawaiian Islands. Such grains as emmer, oats, and wheat are being successfully grown, as is also the purple vetch, which gives promise both as a forage crop and as a green-manure crop. Several acres have been planted with pigeon peas and 12 acres have been devoted to varieties of corn, including pop corn. Other crops under test include Russian flax, edible canna, cassava, upland taro, potatoes, lupine, broomcorn, grain sorghums, and various grasses, among which Napier grass and Harding grass are doing very well. In a test, made to determine the effect of fertilizer on yield of edible canna, the fertilized row yielded 211 pounds of tubers, as compared with 117 and 121 pounds, respectively, in two unfertilized rows (fig. 8).

Approximately 400 chickens were raised at this substation during the year.

REPORT OF EXTENSION AND DEMONSTRATION WORK ON THE ISLAND OF HAWAII

By R. A. GOFF, *Extension Agent*

GLENWOOD SUBSTATION AND DEMONSTRATION FARM

The Glenwood substation and demonstration farm continues to be operated on a self-supporting basis. The work of the farm has been considerably simplified by rearranging experimental fields and fences and by improving the various farm buildings. Part of the poultry flock was disposed of at a good profit and new stock was introduced from the coast. The dairy herd includes 15 milking cows, 1 Holstein bull, and 20 heifers and young animals. The increase in the dairy herd and the improvement in the poultry of the farm are promising indications of the possibilities of developing small farming communities in suitably located areas of the Glenwood district.

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[1] Temporarily employed.

GENERAL ACTIVITIES OF THE EXTENSION AGENT

Talks to school children and homesteaders.—Talks on proper methods of cultivation, drainage, seed varieties, seed selection, and marketing were given school children who were planning vegetable gardens on the grounds of their respective schools, and spraying demonstrations were conducted. Illustrated lectures on crops and livestock raising were given to assembled groups of interested homesteaders living in remote agricultural districts.

Assistance in Boy Scout activities.—The extension agent again acted as scout commissioner and as examiner for boys competing for agricultural merit badges.

School and home-garden work.—The extension agent also served as one of the judges in the Star-Bulletin school and home-garden contests in the districts of Hilo, Hamakua, Kohola, and Kona, and visited both home and school gardens in an effort to encourage the young gardeners.

Boys' and girls' clubs.—Eight club activities were organized on the island of Hawaii under the direction of teachers who have received special training in agriculture. These teachers are deserving of great credit not only for the work they have done but also for carrying on club activities throughout the summer vacation period and for making personal visits to the homes of club members for the purpose of discussing agricultural problems. A large number of the members completed their work and were awarded achievement pins on Achievement Day, when club exhibits were entered at the local school fair. Many of the club exhibits were sent to Hilo for display at the island school fair (fig. 10).

Poultry-club members worked under the many difficulties which are incident to poultry raising, and either raised their chickens from settings of eggs or started with day-old chicks. Purebred stock was secured from local poultrymen and from the poultry department of the University of Hawaii. Members made their own chicken coops and runs from plans and instructions prepared by club leaders and the extension agent. Where the instructions were carefully followed, the coops were draft and rain proof, well ventilated, and protected against the invasion of rats and the mongoose, and 90 per cent of the chickens were raised.

After being repeatedly visited by the club leaders, members of the rabbit club were finally convinced of the danger of overfeeding rabbits and that they must be kept in clean quarters.

Members of the pig club purchased a uniform lot of high-grade gilts at a low cost from the Parker ranch. The last gilt bought was so well cared for by its purchaser that she was awarded second place in point of weight in the contest held at the close of the year. The club leaders, accompanied by members of the club, made monthly visits to each boy's home to record losses or gains in weight of the pigs and to discuss proper methods of care and management. In several instances where gilts made slow gains, owing to feeding in pens with larger pigs, the boys, acting upon the advice of their leader, constructed individual pens for the animals. In other instances the value of skim milk for growing animals was clearly demonstrated, those receiving the milk making decided gains over those deprived of it. Distributions of alfalfa seed were made to the members of this club for the growing of a supplementary feed crop for their pigs.

Distributions of selected seed of Boone County white corn, grown at the Kamuela cooperative experiment station, were made to corn club members, and awards of 25 cents per seed ear were offered members as an inducement to them to grow good seed corn. The greater part of the crop was marketed for table use, and all ears showing promise as seed corn were reserved for future plantings.

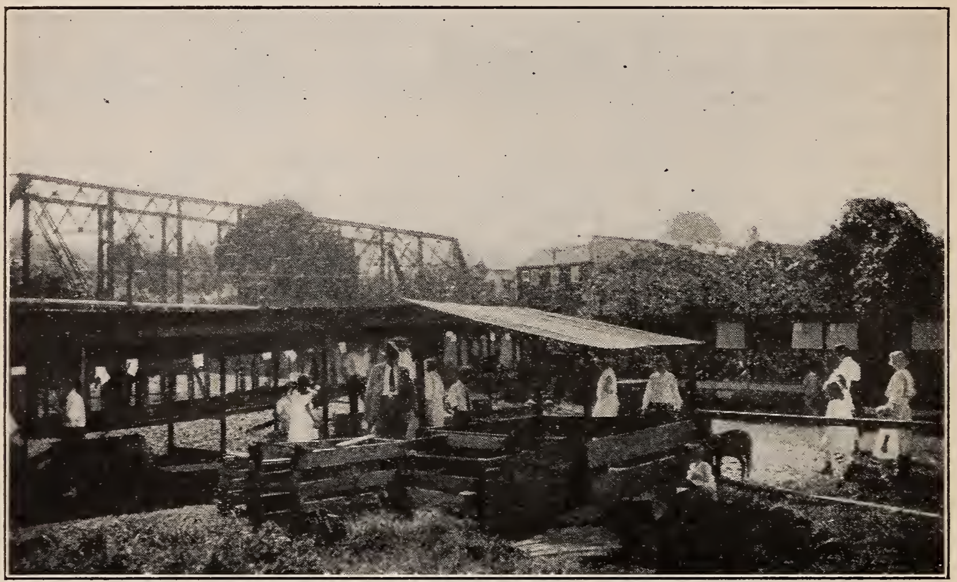

FIG. 10.—Livestock section of Hawaii school fair

Seed distribution.—Seeds, cuttings, and roots of the 10 best forage crops and grasses grown at the Kamuela cooperative experiment station were distributed to homesteaders, ranchers, and school gardens; and advice and assistance relative to the varieties of seed best adapted to the soils and climates of the different localities were given to those desiring help. The extension agent persuaded homesteaders who have planted the greater part of their farms with sugarcane to use at least a portion of the reserved area for growing pigeon peas and elephant grass or alfalfa and Uba cane, so as to raise sufficient feed for their livestock and lessen the need of purchasing imported concentrates.

Distribution of literature.—Newspaper articles dealing with topics of especial interest to homesteaders and others were distributed and copies of the annual reports and bulletins were sent to those requesting them.

Fruit-tree nursery.—The budding of avocados and citrus seedlings in the tree nursery near Hilo was continued during the year, and seedlings which were worked over into winter-bearing trees the preceding year were distributed throughout the island. Granadilla plants from the nursery were also distributed.

Assistance in marketing.—Assistance was given homesteaders who have difficulty in finding a market for their fruit, vegetables, field crops, and livestock products. This difficulty is largely owing to a failure to stabilize and standardize market products and to place advance orders with dealers in Hilo. Arrangements were made with dealers to supply the local market with produce from outlying districts and to cancel part of their orders with coast firms.

Spraying demonstrations.—Demonstrations of the proper methods of combating garden pests and fungus diseases were made in school gardens and in the fields of homesteaders. Bordeaux mixture was prepared and applied for the control of blight, as well as Paris green and arsenical mixtures for garden pests and poisoned baits for cutworms. Methods of eradicating weeds also were demonstrated, together with proper methods of treating the soil for successful pineapple production.

Assistance in planting windbreaks.—Seedlings of varieties of trees suitable for windbreaks were distributed to homesteaders in localities where the winds damage the crops.

Miscellaneous activities.—In an effort to further edible-canna growing for the production of starch for industrial purposes, the extension agent furnished planting material to homesteaders in the Waimea district where the area in canna has been enlarged. He also cooperated with growers who are conducting fertilizer experiments with the crop.

At the Kamuela cooperative experiment station, which is operated by the Parker ranch, plantings were made of about 40 kinds of pasture grasses and crops; and seeds and cuttings from these plantings were distributed to ranchers and homesteaders in all districts of the island.

BOYS' AND GIRLS' CLUB WORK

By Mabel Greene, *Club Leader*

Boys' and girls' clubs were organized in Honolulu, Waialua, and Waimanalo, island of Oahu; in Hilo, Laupahoehoe, Ninole, and Holualoa, island of Hawaii; and in Makawao and Haiku, island of Maui, with a total enrollment of 582 members. At Waimanalo, Oahu, which is the rural unit of the Territorial Normal School, there are four groups, each of which is directed by seven teachers who have had excellent training in leadership for club work. Ninety per cent of the children enrolling submitted reports on their work. The club work now includes 12 clothing clubs, 4 corn clubs, 3 canning clubs, 1 cooking club, 7 garden clubs, 3 pig clubs, 6 poultry clubs, and 2 rabbit clubs.

The clothing-club work has been instrumental in having garment making introduced into the schools as a part of the curricula. Each girl in the club made four pieces of wearing apparel or other articles, and one group of 20 girls from the central grammar school, Honolulu, wore self-made dresses for exhibition at the parentteachers' association meeting in March. The 4-H sewing club exhibited its work in the Kauluwela school on Achievement Day (fig. 11). Talks on the appreciation and value of design and the harmony of color and material in dress were given to the children of both of the above-mentioned schools by a student from the University of Hawaii. The technique of sewing was demonstrated by means of sample books. Some of the books submitted by the children were excellent in workmanship and originality (fig. 12). The care and use of the sewing machine was taught by a commercial demonstrator in one school where the equipment for home economics training is rather poor.

In the poultry club regular meetings were held after school hours, and demonstrations were given in making drinking fountains and in culling for egg production. Pigeons for squab raising were studied, and club tours were made to five different poultry plants where instruction was given in artificial incubation and brooding and in box-house and box-hopper building.

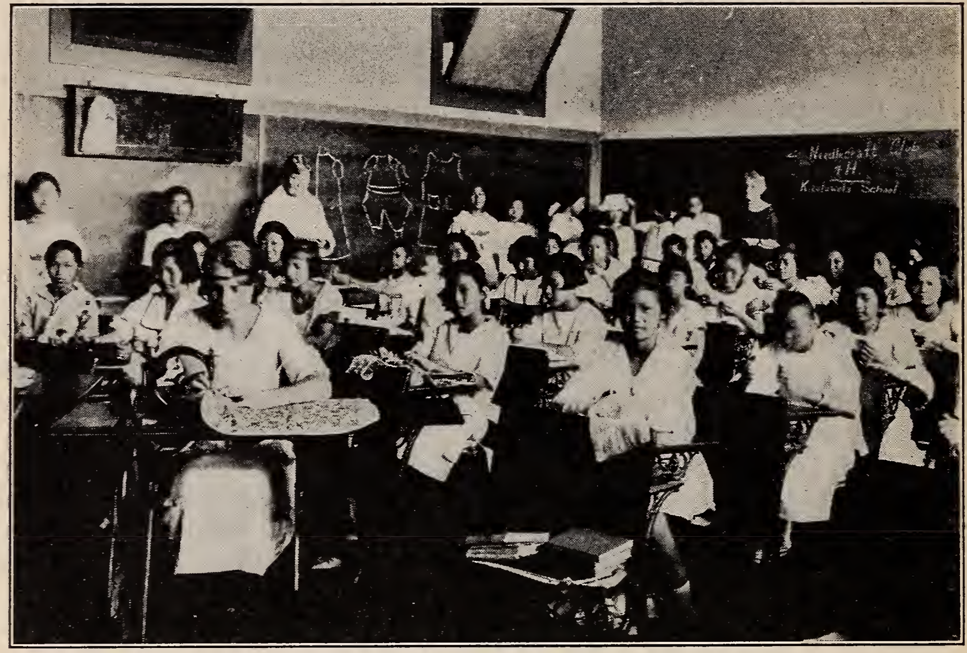

FIG. 11.—4-H sewing club, Kauluwela school, Honolulu

In the garden club the best methods of planting papaya and vegetables and corn for seed production were demonstrated. The young gardeners were also shown how to use carbon bisulphide for exterminating garden pests. The first school garden in Waimanalo, Oahu, was started during the year. Having no garden plats adjoining their plantation homes, the members of this club gladly took the produce of their school garden home for daily use. Many of the vegetables grown were on exhibition on Achievement Day.

The club work was carried on in cooperation with the club division of the Young Women's Christian Association, some private institutions, and with the schools of the island, including the Territorial Normal School. The agricultural school course of study is very closely correlated with the club activities and the school records are similar to those of the clubs. The garden clubs in Waialua, Oahu, as well as those of the Salvation Army Boys' Home, Honolulu, were conducted in cooperation with the Star-Bulletin school-garden contest.

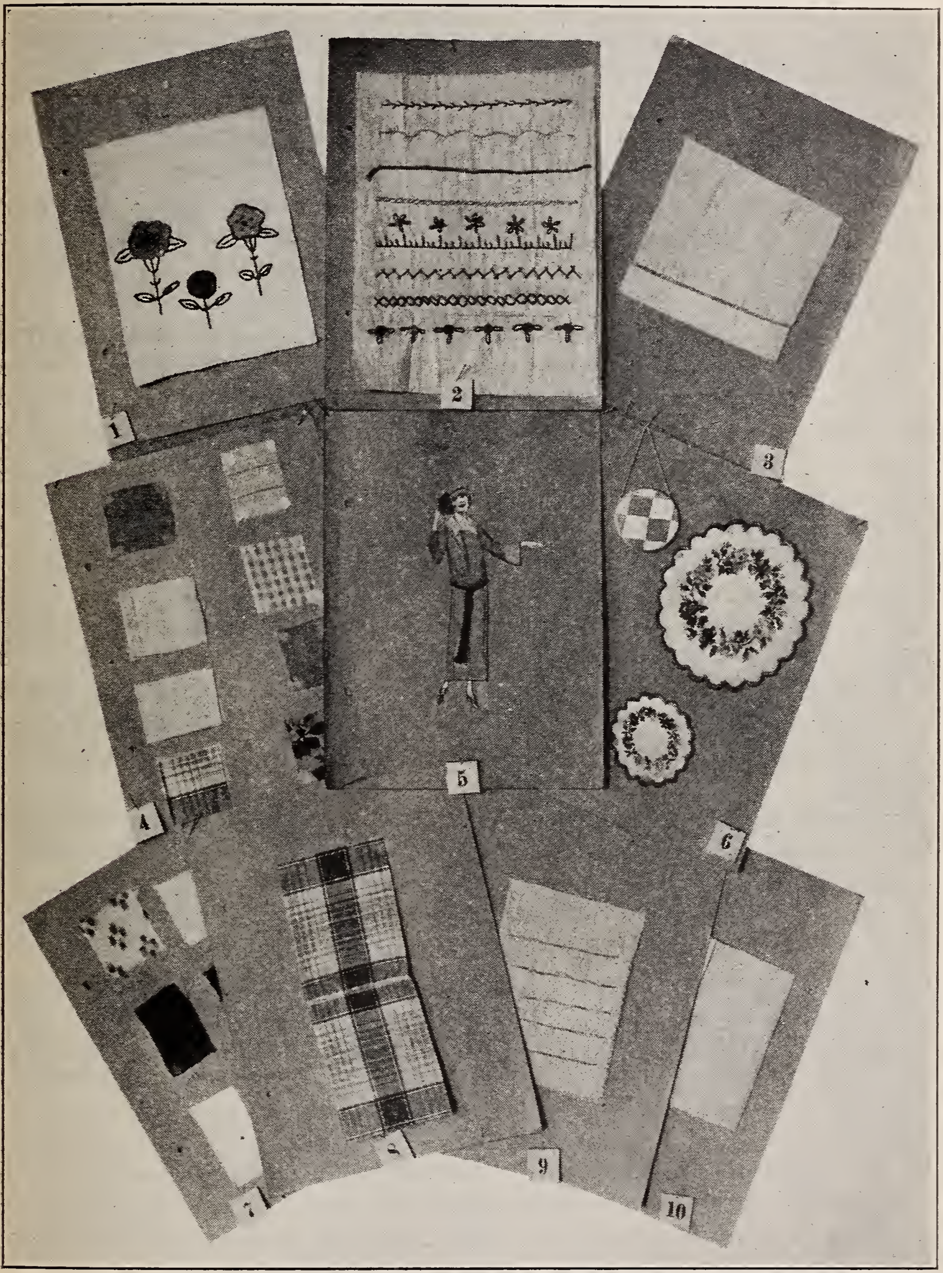

FIG. 12.—Sample pages from sewing club member's book

Hawaii school fair.—The 4-H clubs made creditable exhibits at the Hawaii school fair, which is annually given under the direction of the Hilo Teachers' Union. Boys of the Laupahoehoe pig club, which is a division of the Agricultural Club of Laupahoehoe, conducted an excellent pig-feeding demonstration in conjunction with their exhibit. The animals were grouped along the river bank in sanitary pens in front of each of which was placed a sign giving the club member's name, together with a history of his pig from the time he purchased it. Variations in size and weight of the animals were noted by the club members and found to be due to allowing the pig free range, feeding it alone or with larger animals, or feeding rations lacking concentrates. Two teams of three boys each from the Laupahoehoe pig club and the Hilo Boys' Boarding School participated in the judging contests, and the pigs judged were of the same class (high-grade Berkshires) as were those raised by the club members.

Contests were also held in judging corn, potatoes, and poultry, and the merits of the exhibits were rated by means of score cards. The Laupahoehoe rabbit club was represented in five exhibits. Attractive ribbons and certificates were awarded the winners. Not only are these contests of educational value, but they are also very effective in arousing and stimulating interest in club work.

Club recreational activities.—Recreational activities included holding monthly meetings at the Salvation Army Boys' Home, where agricultural slides were shown, talks on agricultural topics were given, and club melodies were sung; arranging programs in six clubs or communities for the purpose of awarding achievement pins to deserving members; picnicking in company with the Household Arts Sewing Club members, Makawao, Maui, to foster interest in club work and maintain a good club spirit; and granting permission to Kalihi garden club members to view the club slides and to make tours to other gardens. Achievement Day exercises for the Good Morning Garden Club were given at the Leahi Home in conjunction with a school play and were attended by 200 inmates of the institution. Establishing a garden club at this home has served as an incentive to both boys and girls to work hard and with determination to succeed.

Demonstrations in canning.—Although fruits and vegetables grow the year round in Hawaii, some of them can be produced during certain seasons at less expense and in greater amounts than is true of other times. Methods of canning are therefore being developed as a means of promoting the use of fruits and vegetables in the dietary by preserving perishable food products for use when the fresh material is not in season. The extension agent and club leader, working in cooperation with the department of home economics of the Territorial Normal School, conducted a public demonstration in canning chicken in January. Another demonstration in canning fruits and vegetables was given at Haiku, Maui, in February, and two teams from the Haiku canning club demonstrated the canning of fruits and vegetables at the school fair, Maui, in May. Canning pineapples was publicly demonstrated to 200 teachers attending the annual meeting of the Hilo Teachers' Union in February.

ERRATA

Hawaii Station Bulletin 51.—The cuts of Plate III, Figure 1, and Plate IX, Figure 2, should be transposed, the legends remaining, being correct for the cuts as transposed.

Hawaii Station Report, 1922.—In the legend for Plate V, Figure 1, "Beardslee" should read "Macdonald."

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